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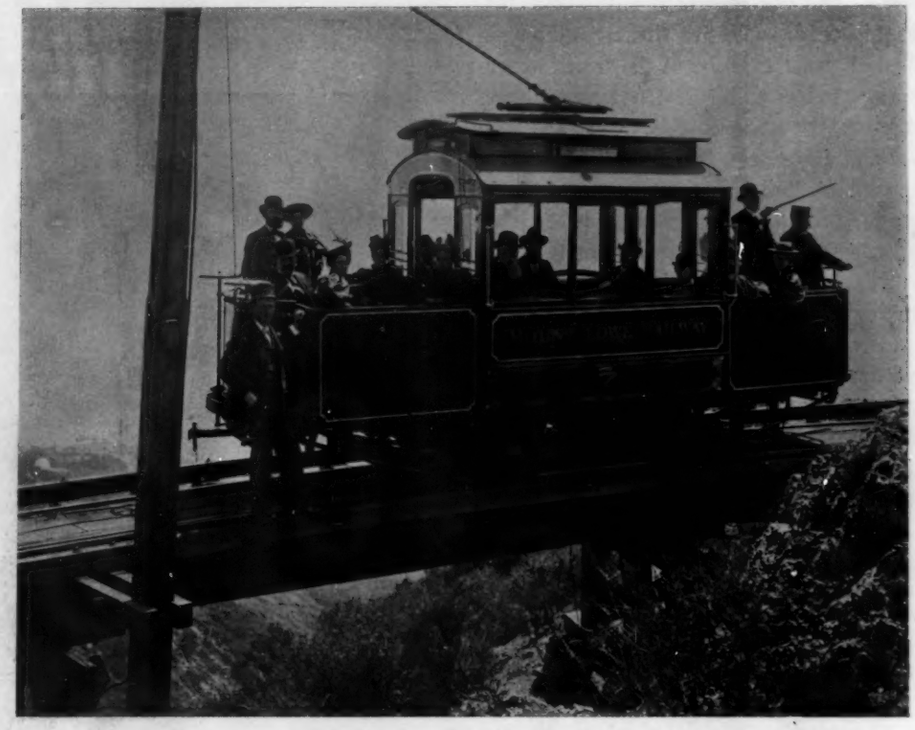
Some Station Wrinkles.

MANY, many times, the central station engineer novel expedient, in order that the rigors of enforced economy may be circumvented, or that forced economy may be circumverted, or that liability of trouble may be averted, or that some detail of operation may be facilitated, or that some little saving in running expenses may be credited, or, in brief, that the general efficiency and reliability of his plant may be increased. It is every manager's endeavor to "round off the corners" of his operating expense sheet —but when he has not the money with which to make advisable changes, he must put his wits to work, and while, oft-times, he is baffled in his endeavor to solve a problem without filing a requisition for expensive apparatus, it is more often that his ingenuity saves the day and provides a means at once simple, cheap and effective. That suggestions may be extended from experiences of different plants throughout the West is the object of this article.

Reference to problems that arise in station practices recalls instances wherein seemingly uncrackable nuts have arisen, and the two cases about to be cited will afford food for cogitation, until their further discussion appears in an early issue of this publication. Meanwhile, the editor will be glad to receive from readers, communications embodying ideas or proposed solutions of the problems.

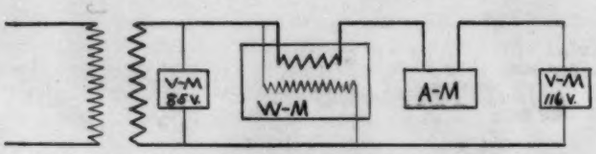


CLIMBING MOUNT LOWE.

The first case is that of the load line of the San Joaquin Electric Co. at Fresno, Cal., the peculiarity of which is that between 7 and 8 o'clock each morning, the power house and sub-station load lines cross, that is the latter is from 50 kw. to 75 kw. in excess of the power house load. The transmission line is 35 miles long, the initial voltage is 11,300, the circuit is No. 3 B. & S., the sub-station load consists of about 8,000 incandescent lights and 1,000 h. p. in power service, about equally divided between motors of the synchronous and induction types. The readings are volt-amperes, as the stations

are not provided with indicating or recording wattmeters. Query—Why this habitual crossing of the load lines?

In the second case the query is based on an anomaly in a voltmeter reading, and the experiment was performed at the laboratory of the Chief Electrician of the



AN ANOMALOUS VOLTMETER READING.

City of Alameda, Cal. The leakage of a twenty-light transformer was under test, the connections being as per diagram above, where with 2,320 volts primary, 116 volts is obtained from the secondary. These are the normal voltages of the plant, the periodicity being 7,200 alternations per minute. A standard Weston indicating wattmeter, a Whitney ammeter, and a Weston alternating current voltmeter were cut in the secondary, as shown, the circuit consisting of about 50 feet of No. 14 cotton covered flexible cord. Under these conditions, the wattmeter indicated 30 watts to be at the transformer leakage, the ampereage being so light as not to register on the amperemeter. In the final experiment, the Weston voltmeter was cut in across the leads at the transformer. The lamps in the building remained at proper voltage, showing no disturbance in the normal condition, but the Weston voltmeter connected, as indicated in diagram to the terminals of the transformer under test, gave a reading of but 85 volts! By a chance suggestion, the voltmeter was then placed across the flexible cord at the end farthest from the transformer, when it showed the full potential of 116 volts to be on the circuit. This situation was incomprehensible and both readings were taken three times over, with the same results. Query: What occasions this false potential reading?

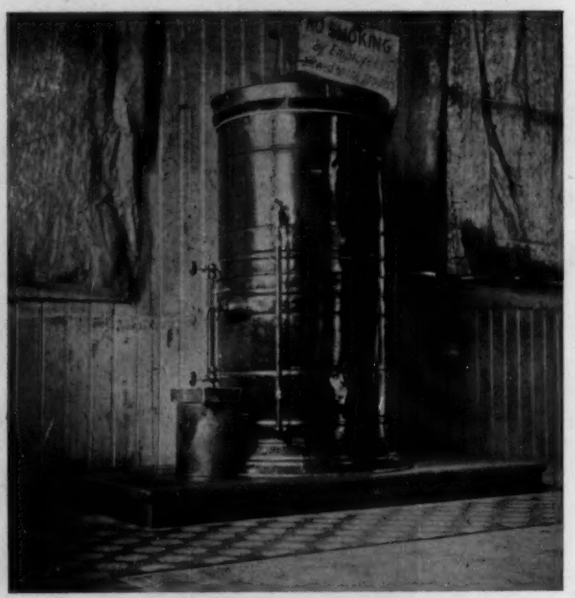
Part I

HOW MOUNT LOWE IS CLIMBED.

The means by which the ubiquitous trolley takes passengers, in a ride of an hour or so, from the orange groves of Pasadena, or more properly Altadena, up thousands of feet to the snows of Mount Lowe, in Southern California, are such as would tend to confirm, in the engineering mind at least, the extravagent stories that have been soberly told anent the wildness and wooliness of the West. The illustration appearing on page 49 shows the electric car, or chariot, as it is termed, and incidentally gives visual demonstration that the road is a mountain railway indeed.

The complication of the power plant, however, presents the most interesting engineering feature of the system. It is in three distinct divisions, two of which, each contain a direct current electric motor, two gasoline engines, and a railway generator, while at Rubio Canyon, an intermediate point, is a tangential water wheel and constant potential generator, used in conjunction with the electric motors in the power houses for starting the gasoline engines, and also for furnishing current for operating the electric motor that hauls the car by cable up the incline at Rubio Canyon.

The modus operandi of the system will convey a better idea of its arrangement: The amount of water available for power purposes is limited and even sufficient to operate the plant as laid out is obtained only by impounding. The use of gasoline engines was determined upon as affording the cheapest power and four were installed—two at the Altadena power house at the foot of the mountain, and two at Echo Mountain Hotel, about midway up the mountain. But three or four trips are made daily and as there is but one car on each of the two divisions, and as these cars connect, only one section is operated at a time. The first section extends from Altadena to the foot of the incline in Rubio Canyon, where the water wheel plant is located. At the head of the incline is the hotel, dimly shown in the lower left hand corner of the illustration given. Here is a duplicate of

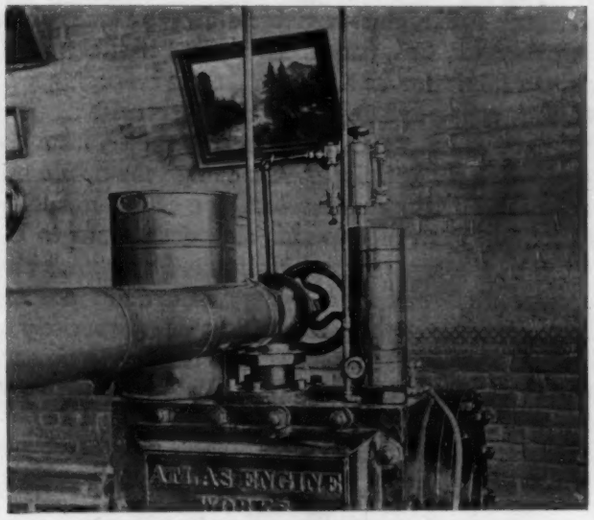


A HOME-MADE OIL FILTER.

the gas engine and dynamo plant at Altadena and from here the "chariot," as the electric car is called, takes the tourist on up to the summit of Mount Lowe. The beauty and grandeur of the ride makes it a never-to-be-forgotten one.

When all is ready for the ascent, the attendant in the station at Altadena telephones that fact to the water wheel station at the foot of the incline and the water wheel and generator are started, which charges the trolley wire, from which is operated an Edison bi-polar motor in the Altadena power house. This motor is started by

means of a barrel filled with salt water, and a sash weight, together forming an improvised starting box. Once under way, the motor drives a jack shaft, to which are belted two gasoline engines through clutch pulleys. When the shaft is up to speed, the clutch pulley of the first engine is thrown in and after the engine has pumped



THE NOBLE LUBRICATOR RESERVOIR.

up sufficient pressure for running, it is started, using a primary battery for ignition from the spark coil. After the first gasoline engine is in operation, the attendant throws the motor belt from off the jack shaft with a stick, then starts from the gasoline engine a little low voltage direct current generator for the spark coil, thereby cutting out the primary battery. The attendant then starts the second engine from the first one through the jack shaft and its clutch pulley and then telephones the power house at Rubio Canyon to shut down the water wheel. He next throws the clutch that starts a Westinghouse railway generator of an old style that resembles a Waterhouse arc machine, soon after which the car may commence its 25-minute climb up the lower section of the road. As soon as the car arrives at its destination, the Altadena power house is notified by telephone and the gasoline engines are shut down until the time arrives for the next trip, some four hours later.

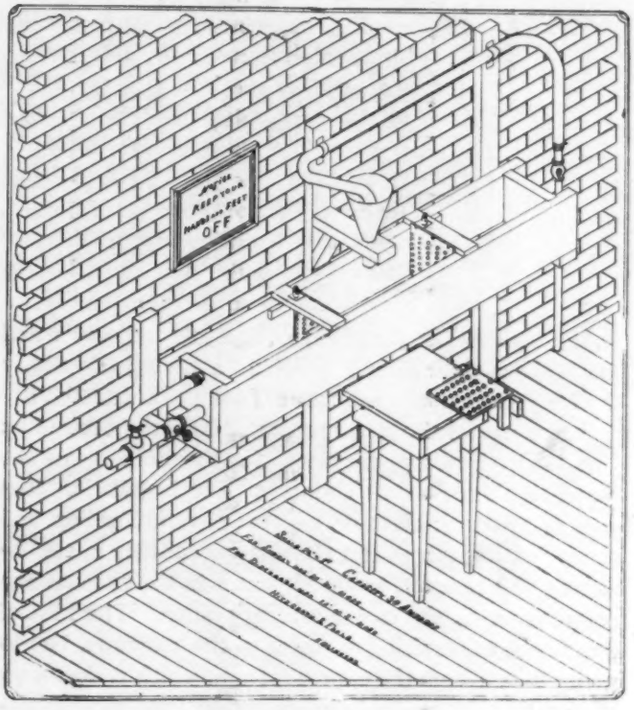
This takes the car to the foot of the incline, where the passengers change to a special cable car, and when all is ready, the water wheel in Rubio Canyon is again started and the generator it drives furnishes current to an Electrical Engineering Company's motor which hauls the car to Echo Mountain Hotel. At this point there is a power house equipment that is practically a duplicate of that at Altadena, and when the tourists have changed cars for the final climb, the gas engines in the Echo Mountain station are started by an electric motor taking power from the water wheel plant precisely as was done at Altadena, and after the plant is in operation, the water wheel plant is shut down as before, and the chariot ascends to the summit. The descent is made in safety by braking —as the maximum grades vary from six to seven per cent.

It can not be stated that a description of the Mount Lowe installation is given with any other idea in mind than that of the novelty it presents.

Part ii

THE SAVING OF OIL.

Every station has its peculiarities regarding the using, saving, purifying, and re-using of lubricating oil, but many appreciate at too late a period that the fullest saving of oil becomes seriously embarrassed when engines are mounted on plain concrete foundations. Painting foundations renders them non-absorptive, hence economy in oil is effected to the greatest advantage in stations having the engine foundations so coated that such oil as accumulates on them may be gathered and filtered, together with that taken from the drip pans. But the route from drip pan and waste bunch to the filter forms an oft-told tale, though seldom is it recorded that a thousand horse power plant has consumed eight gallons of lubricating oil for each night's run. Such was the record of the Electric Improvement Company of San Jose, until about two years ago, when the incumbent, Mr. George J. Johnson, took charge of the engine room. Mr. Johnson was formerly a railroad engineer, where the

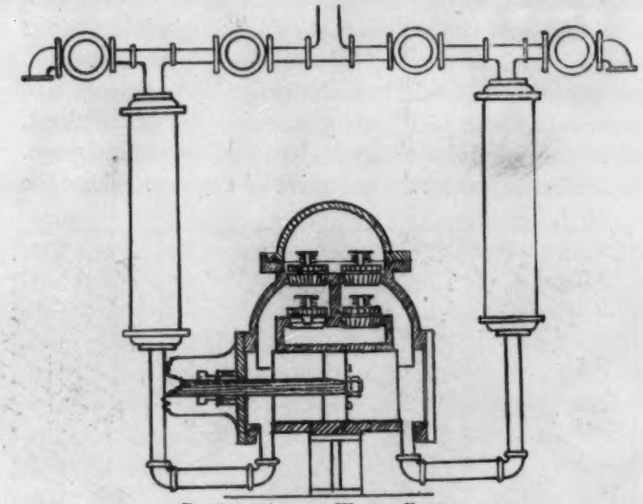


A 7000-OLT WATER RHEOSTAT.

best record of economy was not only recognized by a prize, but became a matter of great pride. His attention was first directed to saving oil in the San Jose station and through the home-made appliances about to be described, instead of using eight gallons of oil per day, a

barrel of 52½ gals. of the same oil was made to run the plant for seven months. This saving was not effected through the scant use of oil, for nineteen quarts of oil is filtered daily, there being added to this filtration each day enough new oil to restore the loss in quantity and body.

The oil caught in the drip pans, together with that which is wrung out of used waste by an ordinary clothes wringer, is run into a receiver, consisting of an oil barrel with a gauge glass in the side. It is in this tank that grit settles, and the oil which rises to the surface is taken to two filters, practically identical in external appearance and one of which is illustrated on page 50. The first of these consists of a series of strainers of varying degrees of fineness, and the second, which is called the refiner, differs from the first only in that its filters or strainers are of finer and closer materials, such as flannel or other woolen fabrics. In each filter the oil is washed by passing through water, and after passing through this course, the oil is as clean as when new, though of slightly less body. The outfit did not cost $25.00, yet it and painstaking wiping have effected a saving of nearly double that amount each month over the old method.



PUMPING AIR BY WATER PISTONS.

A new use for the steam separator has been devised by Mr. I. O. Crosscup, engineer for the building of the San Francisco Savings Union. The installation consists of hydraulic elevator, isolated electric lighting and steam heating plants and the novelty consists in the insertion of a Stratton steam separator in the exhaust line before entering the steam heating system. The idea of this is not to furnish dry steam to the radiators, but to wring the oil from the exhaust steam, which it does very effectually. A two-fold benefit results from this: namely, the efficiency and utility of the system is not seriously impaired by precipitations from the use of wet oil-soaked steam and, second, oil is saved which would otherwise be lost in the heating system, or be exhausted into the atmosphere.

In Mr. Crosscup's installation the separator drains into an iron tank with gauge glass and containing globe valves and piping for draining off the oil and water respectively. The oil is then clarified by hot filtration and used over again, and so thorough is the economy in the use of oil carried, that the total oil item amounts to but a few dollars yearly.

Some engineers have reason to complain of the small lubricators with which their engines are supplied, but Mr. Frank Noble, chief engineer of the Sanger Lumber Co., of Sanger, Cal., has placed a supplementary reservoir to a lubricator, as shown in the cut on page 51. In this, the supplemental reservoir may consist of iron pipe, capped, or any other suitable chamber, from the top of which a short nipple extends into the orifice originally filled by the condensation pipe of the lubricator. The condensation pipe is now extended down to the bottom of the supplemental reservoir, from which also extends a drain pipe for carrying off the drain in filling the lubricator. The apparatus is then used precisely as though it were a simple lubricator, the only difference being that while it takes longer in filling, it runs without refilling a correspondingly longer time.

Part iii

WATER RHEOSTATS.

There is a time in the history of every station, and there are many times in the history of some stations, when it becomes necessary to load both prime movers and generators up to full capacity; and it is seldom that commercial conditions are such as to permit the throwing of regular service on to the machine so as to obtain a full load for a given period. In other instances, it is necessary that the load thrown on generators should be of a non-inductive nature. Originally resistance racks supporting spirals of iron wire were used, but these were cumbersome, expensive and unsatisfactory, the latter condition being mainly due to the fact that on heating, the wire would soften, which would bring the turns of the spirals into contact, causing short circuiting, and so forming an unreliable, if not dangerous, combination. Now, however, the eminent suitability of water rheostats is universally recognised for any amount of load or any voltage, but the fact remains that the proper methods of constructing and using these appliances are not well understood.

Pure water is of very high resistance and for this reason it is necessary, in absorbing energy under low voltages, to increase its conductivity by the addition of common salt, or preferably, sulphate of sodium. Chloride of sodium, or common salt, when in solution, possesses the property common to carbon in that its conductivity increases with the temperature, and this fact renders its solution unsuitable as an electrolyte for water rheostats where exact measurements are necessary. To illustrate further, if a rheostat contains a fixed solution of sodium chloride and if the electrodes are rigidly separated a fixed distance, the ampereage which the rheostat

will absorb, will increase directly with the rise in the temperature of the water until the boiling point is reached,—and it is never advisable to permit the water in the rheostat to reach the boiling point. With sulphate of sodium, however, this property exists in a much less marked degree, for after the tank has been fairly well warmed up, the variations in the resistance of the electrolyte from fluctuations in load, becomes a negligible factor. Foaming does not occur in properly manipulated rheostats when either common salt or sulphate of soda are used, but almost invariably becomes an annoyance when barrels are impressed into service, doubtless for the reason that oil barrels are generally used and the oil remaining in them saponifies with the soda.

An instance illustrating the use of water rheostats of the nature described was that occurring during the test of the power plant at Bakersfield, Cal. The object of the experiment was to determine the efficiency of the set of Girard wheels that are direct coupled to a 450 kilowatt, 500-volt, three-phase generator, as illustrated on page 91 of this Journal for August last (Vol. IV., No. 5). The water rheostats consisted of three separate redwood tanks, each measuring 4x4x6 feet in size, and each containing two sheet iron electrodes of such size as to give five inches in the clear when suspended in the tanks. Three of the six electrodes, one from each tank, were coupled together in short circuit, while the three legs from the three-phase generator were each taken to the remaining electrode of its respective tank. Each phase, therefore, was in this manner provided with an independent rheostat which was capable of absorbing 150 kilowatts. The amount of load on each phase was regulated by varying the separation between the electrodes of its particular tank, and so well proportioned was the amount of sulphate of soda placed in the tank that the rheostats would carry a load of 500 horse power for three hours or more without boiling.

It should be emphasized that it is unnecessary to increase the conductivity of water except for potentials below 1,000 volts, and that the absorbing of energy under higher potential, is in some respects a more simple matter than at low potentials. At high potentials the conductivity of the water is not increased or altered in any way and the amount of the resistance is gauged only by varying the separation between the electrodes. The operation of a water rheostat absorbing energy under high potential is well illustrated in the method pursued in the experiment made over the transmission plant of the Pioneer Electric Power Co., as editorially referred to, in these columns last month (page 44). The water rheostats for this test were arranged precisely as in the Bakersfield test, the only difference being that each of the three tanks measured eight feet in length by three feet in depth by four feet in width, and was mounted on three double petticoat, deep groove glass insulators. The electrodes consisted of three-eighths inch sheet steel of such size as to give one inch clearance on all sides. Each tank, moreover, absorbed 250 kilowatts at 2,300 volts. instead of 150 kilowatts at 500 volts, as in the Bakersfield experiment.

The distinguishing feature in the use of water rheostats for high potentials, lies in the advisability of a constant circulation of water through the tank in order to keep the temperature as low as possible, and to a minor degree, to wash off the bubbles of oxygen and hydrogen from the electrodes, so that the resistance of the electrolyte may not be increased thereby. This circulation is accomplished by running a stream of water into the tank through a hose, as obviously to carry the water to the tank through an iron pipe would ground the electrolyte,—and grounds are never desirable. The overflow or waste from the tank is also carried off through a hose, the length of which, if the water is reasonably pure, and if the hose is of less than an inch in diameter, need not be more than twelve or fifteen feet for potentials up to 2,500 volts. The water used in the test at the Pioneer plant was of unusual purity, being from the snows of the Wasatch range, a few miles above the plant, and so great was its resistance that no leakage to ground could be observed on holding the finger in the stream running from the outlet of the tank.

The outline drawing on page 51 illustrates the design of water rheostat due to Messrs. Hitzeroth and Poole, and as used by the San Francisco Gas & Electric Co. for testing 2,200 volt alternators and 10 ampere arc machines of various capacities up to 7,000 volts. The device is very simple, consisting of a long wooden box, or trough, closed at the ends, and painted inside and out with P. & B. paint. In this trough are supported two electrodes of plate carbon. These electrodes each measure ten inches square, by one-half an inch in thickness, and are each perforated with forty or fifty one-half inch holes to facilitate the circulation of water. Fresh water from the city main is run into the tank continuously during use, through about twelve feet of one-half inch rubber hose, and the waste water is let to the sewer through about the same length of hose, no grounding resulting from the arrangement. With this rheostat, as with all others, the conductivity of the water varies with its height and temperature, but when it is filled to within two inches of the top and after it has reached a practically fixed temperature, its resistance is such that with a potential of 2,300 volts, a separation of 10¼ inches between the carbon plates gives an approximate current of 20 amperes; 15½ inches gives approximately 15 amperes and 19¾ inches gives approximately 10 amperes.

Part iv

COMPRESSED AIR.

If even a partial realization was had of the manifold uses to which compressed air could be put as a cleansing agent in and about electric light stations, the system would be installed in every plant regardless of its size. For cleaning armatures, fields or bus bars, or for blowing out arc lamps, transformers or switchboard appli-

ances, it is simply indispensable, and the saving that it effects from armature burnouts alone by reason of the facilities that it extends for always keeping them scrupulously clear from any dust or foreign particles that may chafe and eventually result in short circuiting and burn out, alone demonstrates that it is the safest insurance that it is possible to have against trouble.

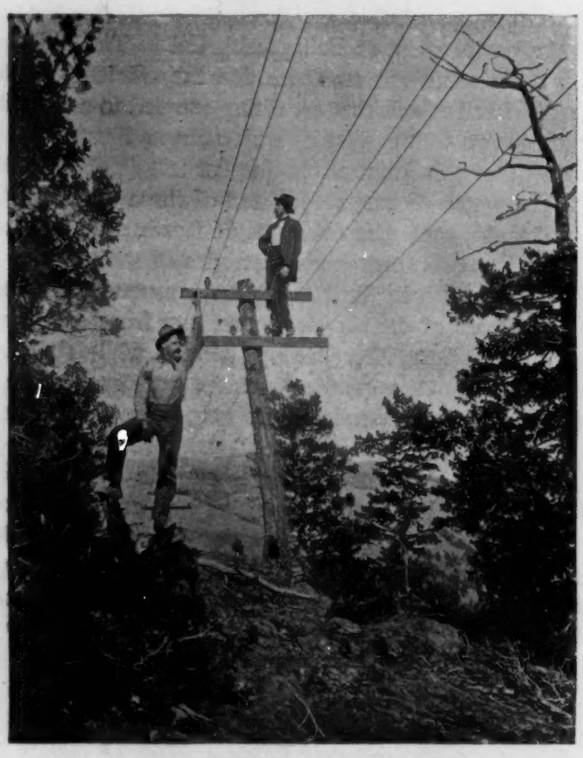
The larger stations may easily afford the cost of a complete compressor plant, the best efficiency in the operation of which will be attained by driving the compressor from an electric motor rather than by an independent steam engine. The smaller stations may now find on the market small compressors that will satisfactorily fill every requirement and these may be driven by belting wherever it may be convenient to do so. Those stations, however, which look upon the installation of an air compressor as a luxury rather than as a necessity, yet which feel that it may be of some slight utility, will find a fairly satisfactory substitute in the novel air compressing apparatus in use by the Pioneer Electric Light Works of Sanger, Cal. The outfit, including receiver, should not cost more than $20.00, if it be installed by the engineer during odd moments, and if he uses such materials in its construction as are always to be found about an electric lighting plant.

Briefly described and referring to the accompanying outline drawing on page 52, the apparatus consists of two upright columns in open connection by suitable pipe fittings to the front and rear chambers of the plunger of one side of a duplex pump. The fittings may be attached to the pump through the holes that are tapped in to the bottom of the pump chambers for the pet cocks that are sometimes used for draining the chambers, and it is advisable that the fittings be made each through an angle valve so that the air pump may be closed down readily. To avoid confusion, however, these angle valves are omitted from the sketch.

Inasmuch as the passage from each side of the plunger to the upright columns is always free while the air pump is in operation, it is clear that as the plunger makes its stroke from end to end, the level of water in the columns will rise and fall in step with the stroke of the plunger, providing the upper ends of the columns are unobstructed. If, however, the upper ends of the columns are obstructed, such air as may be in them will be alternately compressed or rarified according to whether the level of water in the column rises or falls. The levels of water in the columns are, therefore, constantly changing, hence the water therein becomes a liquid piston, oscillating in step with the pump plunger and, in fact, it transmits the motion and energy of the piston from the plunger chamber to the upright columns, so far as the capacity of the fittings admit.

But instead of being free and unobstructed, the upper ends of the columns are provided with four check valves, shown in circular form in the drawing. These are connected as in an ordinary single acting plunger pump so that when the level of the water in the left-hand column, for instance, falls, the check valve at the extreme left, opens, admitting air to the vacuum caused by the descent of the water piston, while the adjoining check valve to the left of the center closes. On the reverse of the stroke, the check valves naturally reverse their positions, the first closing and the latter opening, thus affording a passage for the relief of the compressed air, which has been compressed by the rise of the water piston. The side outlet of the center tee passes through a globe or gate valve whence the air is led to any suitable receiver—an ordinary fifty gallon house boiler for water-back service answers admirably.

The arrangement may be attached to the boiler feed pump, which will be affected by it only to the extent of diminishing its pumping capacity. At first thought it may appear that such connection will be impossible, for the reason that there is nothing to prevent the atmosphere from entering the suction chamber through the open check valves and upright columns, but in actual use this does not occur if the pipe fittings are sufficiently small and if the angle valves previously referred to are never opened until the pump is in full and proper operation. The tendency of the arrangement is of course to afford an ingress of air to the suction chamber, but the loss of water from the columns in this way by atmospheric pressure is much less than is the increase of water



THE CHEAPEST THAT "EVER HAPPENED."

therein from the excess pressure of the up-stroke, which may be at more than double atmospheric pressure. It is difficult to so design and regulate the apparatus so that no water will be thrown over into the receiver, but the quantity of this water is not great and is easily taken care of by occasionally draining the receiver. Pipe fitters know that steam joints must be made tight; that water is more difficult to confine in piping than steam, and that compressed air is the hardest of all to restrain, hence the necessity for the most careful workmanship, particularly in the matter of check valves.

No attempt has been made in the cut to draw the parts to scale, but the apparatus, when propely proportioned and carefully handled, will give satisfactory service for air pressures up to forty pounds per square inch, which will answer for the purposes to which it is to be put. It will serve its purpose well, however, if it does nothing more than convince the station manager that compressed

air is an indispensable commodity to every economically-run electric station, and when he has this conviction, he will install a regularly built compressor of recognized worth—they do not cost much—and will do away with the make-shift device here described.

Part v

MISCELLANEOUS.

The reluctance which American central station engineers have to the coupling of alternators in parallel, and the growing necessity for doing away with the great multiplicity of small primary circuits and the equally great nuisance (to say nothing of the inefficiency) of an independent alternator for each such circuit, will attach especial interest to the method by which the Portland (Or.) General Electric Company heroically parallels its single-phase alternators. It couples the shafts of the machines rigidly together so as to be mechanically in step, and operates the two machines as a single generator, sending their output down to Portland over a single circuit.

The single phasers so used are two of the three original 80 kilowatt, 4,000 volt, 16,000 alternation machines that formed the initial generator plant of the company for the utilization of the Falls of the Willamette in the incandescent lighting of Portland, eight years ago. They have now been rewound with ribbon wire and speeded up so that their combined output is 250 kilowatts, instead of 160 kilowatts as originally designed, and their heating is less than formerly. On one occasion they carried a load of 266 kilowatts during a night's run.

The instance finds an approach to a parallel in the two-phase power transmission plant recently installed by the Fort Wayne Electric Corporation at Logan, Utah, where two separate single phasers were mechanically coupled together, not in step, as in the Portland plant, but at 180 degrees, with the phases 60 degrees apart, thereby making a two-phase generator from the two machines. Three single phase machines, mechanically coupled together so that their phases shall be 120 degrees apart, form the Fort Wayne three-phase generator.

In the matter of spark coils, the San Francisco Gas & Electric Company has introduced a device for use on its Edison three-wire circuits that has called forth benedictions from every local operator of gas engines that are ignited by electric sparks. The device consists of a spark coil about five inches in length and wound to a diameter of about two and one-half inches with number 22, B. & S. cotton covered magnet wire. The coil is connected in series with a 110-volt incandescent lamp and then cut in across one side of the three-wire circuit, and all who have had to do with gas engines and have raised their voices in condemnation of the unreliability of open circuit batteries and of small dynamos for ignition purposes, have found a happy surcease from every whit of aggravation on the ignition score.

A third 400 kilowatt rotary transformer has been added to the two rotors of equal size in the sub-station of the Portland General Electric Company, and this new one, like the others, takes three phase current at 350 volts and transforms it into direct current at about 550 volts for the operation of street railway circuits. The sub-station is now never without the hum of the rotors for the truth is that whether loaded or idle, a rotor is never shut down unless it becomes necessary to trim the commutator. The reason for this is that while it is easy to put the machines in operation, it is not always that the operator is so fortunate as to hit the right interval of time that will give the proper polarity on the direct current side. Indeed, the perversity of the inanimate seems to be a particularly active genii when a rotary transformer is to be started, for while the right combination may sometimes be struck at once, it is more often that fifteen minutes are consumed before positive will come from the brushes where positive ought to be. Some one should devise a polarity teaser that would coax the three phases to deliver the proper potential on demand and without any foolishness about it.

An instance of the ease with which the voltage of transmission plants operating on the three phase system may be altered is about to be demonstrated by the San Joaquin Electric Company, which, in extending its transmission line to Hanford, 32 miles beyond Fresno, is to change its transformer connections throughout from delta to "Y," thereby giving it an initial potential at the power house of nearly 19,400 volts, instead of 11,200 volts as at present. The change will cause a shut-down for three hours or so and the capacity of the line for power purposes will be nearly doubled thereby. Incidentally, this extension again will place the Fresno transmission ahead of all others in the world in the dual capacity of the longest distance, 67 miles, and of the highest potential, 19,400 volts. The extension to Hanford will be in operation within sixty days, the contract for the work having been let to the Finance and Construction Company of San Francisco under that proviso.

If there is anything about the electric transmission plant of the Diamond Hill Gold Mining Company, of Broadwater County, Montana, entitling it to distinction, it lies in the pole line, for Nature dug the holes, furnished and set the poles, and did all but string the circuits.

Water for the operation of the plant is taken from Crow creek, whence it is carried through two and one-half miles of 3 by 4-foot flume to a point on the creek where a head of 154 feet becomes available. The water is applied to four Pelton wheels which drive a 500 k. w.

General Electric three-phase generator, delivering 2400 volts to the three-mile transmission line direct. At the mine are operated two 125 h. p. induction motors for the stamp mill, one 125 h. p. induction motor for the compressor, one 50 h. p. induction motor for the rock breakers, and two 30 h. p. induction motors for the concentrators, besides burning about 200 incandescent lamps in the mill. The stamps weigh about 1300 lbs., making one hundred drops per minute.

There is, therefore, nothing unusual about the transmission or its utilization, except in the fact that, as shown in the illustration, young trees are used for poles and, moreover, no great exertion was made to select high trees—that is, trees equalling the height of the ordinary pole, nor are the line circuits always run sufficiently high to prevent their being reached from the ground with but little effort.

Transmission

THE BURNING OF INSULATOR PINS.

By W. Stuart-Smith.

Experience with high-tension lines in California has developed the fact that with voltages of 10,000 and over, the production of insulators that will not be punctured under the static strain, or that will not allow the current to soak through the body, is not the only requisite to maintenance of line. With potentials up to, and somewhat exceeding 5,000 volts, the protection of a sufficiently resisting insulator was all that was requisite, but when potentials of 10,000 volts had been in use for a year, it

A View of a Burned-Off Pin.

was found that during the storms of the second winter the pins began to give way and during storms of several days duration, it is no uncommon thing to replace from half a dozen to a dozen pins. Destruction occurs in a variety of ways, but the most common is for the pin to burn off just abreast the lip of the inner petticoat, as shown in the illustration herewith.

Discussion with the operating engineers of plants has developed the fact that this burning is generally considered to be due to heavy leakage over the surface of the insulator and wet pin, the idea being that the volume is sufficiently great to heat the pin to the charring point. If this was the case the pins would be generally found charred throughout the body, with maximum burn near the line of contact of insulator and pin and extending somewhat into the threaded portion of the insulator. As a matter of fact, the burn is generally confined to a very short length just under the lip of the inner petticoat, the lower portion of the pin and the portion screwed into

The Burned Pin.

the insulator being intact; also where the inner petticoat has considerable depth the pin shows no sign of burn for a distance of from one-fourth to one-half an inch below the contact line of pin and insulator. This proves conclusively that the current does not creep over the insulator surface to contact with pin and then down the latter, because in this case the line of contact would show the greatest burn, whereas it shows absolutely none at all.

The accompanying illustrations are from photographs of the portion of such a burned-off pin left in the insulator and show clearly the clean burn-off abreast the lip of the petticoat and also the fact that the portion of the pin in the insulator and for some distance below the contact line of pin (also shown) and insulator is absolutely free from burn.

A little consideration will show that the burning is probably due to sparks passing horizontally between the pin and the lower edge of the inner petticoat. It seems probable that the electricity accumulates on the edge of the petticoat, the potential increasing until the strain becomes so great that the dielectric is pierced and a spark passes between the edge of the petticoat and the pin. Owing to the pin presenting a flat surface and the edge of the insulator being rounded, a very considerable quantity will pass at each discharge, and the burning power will be comparatively great. The manner in which these burnoffs occur is difficult to explain, except as above.

It is possible that the electricity reaches the edge of the inner petticoat by jumping from one petticoat edge to another, the path through the air being filled with spray perhaps offering less resistance than the long surfaces over the petticoats.

Pins burned in this manner are never seen on lines with a potential of 5000 volts; they are comparatively frequent on 10,000 volt lines and with potentials much in excess of this the passing of sparks and consequent burning will be so great as to render the use of plain wooden pins impossible.

It is probable that the use of some such device as the porcelain sleeve on the lower portion of the pin, introduced by Mr. Fred M. Locke, will prove effective, owing to the sparking taking place between incombustible surfaces. It is also possible that plain wooden pins could be used if a narrow metal band was placed around it just below the edge of the petticoat lip, said band being provided with two or three points extending towards the lip and taking the discharge. The quantity of electricity passing with each spark would be smaller than when the discharge passes between blunt surfaces and the burning power would be small, also the surfaces between which it passes would be incombustible.

REPRESENTATIVES OF ITS BEST PRACTICES.

WHEN the largest electrical manufacturing establishment in the world undertakes the installation of an electrical power transmission plant, it is certain that it will embody in the work the highest standard of excellence that its experience (which is the experience of a majority of plants of a similar nature) has taught it to be best. It is this idea that attaches more than usual importance to the plant which is being installed by the General Electric Company at Mechanicville, N. Y., for transmitting power to the General Electric Works at Schenectady, eighteen miles distant. The hydraulic portion of the plant has been completed and the entire installation will be in operation early in 1898. About one-third of the output of the plant will be utilized at Schenectady and the remaining power will be transmitted to Troy, and possibly to Albany.

The Mechanicville-Schenectady transmission may, therefore, be accepted as representative of the highest state of perfection reached by the General Electric Company in its apparatus for this class of work, hence the reasons why certain electrical features possessing novelty have been adopted as affording the best means for satisfying the conditions, and these reasons are fully decribed by Mr. C. P. Steinmitz in a recent contribution to the Electrical World. (Vol. XXX, No. 20.)

The frequency selected is that best suited for lighting, synchronous and induction motors, and conversion to direct current. Thus the frequencies of 125 cycles and of 25 cycles were excluded, the one as too high for rotary converters and large induction motors, the other as unfit for lighting and less suitable for smaller motors, and hence the choice lay between the standard frequencies of 40 cycles and of 60 cycles. The former was adopted as somewhat better suited for rotary converter work and for induction motors. The generators, of the type A. T. B. 40-750-120-12000, are 40 cycles unitooth three-phase revolving field type, of 40 poles and 750-kw. rating, wound to generate directly 12,000 volts, so as to avoid the necessity of step-up transformers. The revolving field type was adopted in preference to the revolving armature type, since the stationary armature winding of the former allows the construction of a generator to produce directly the transmission voltage.

The revolving field type, states Mr. Steinmitz, was preferred to the inductor type, since the latter requires very high density in the magnetic structure, and thus gives a lesser margin in voltage and in speed than the revolving field type, which latter allows the use of fairly low saturation of the magnetic circuit, thus giving a nearly straight saturation curve. Such a saturation curve, while making the machine slightly inferior in regulation to the same machine with an over-saturated magnetic circuit, is preferable in power transmission. It allows a considerable increase of voltage when needed, for instance, to cover excessive drop in voltage in lines due to heavy loads, etc., and permits the voltage to be maintained, even if the speed is low, as in the case of high water, etc. The generators are arranged to be operated in parallel at constant voltage in the generating station.

At first, 2,000 horse power will be transmitted to the General Electric Company's factories at Schenectady over a line of about eighteen miles length, consisting of three wires of No. 000 B. & S. This large size of wire has been chosen in preference to the use of several small wires in multiple in order to give the line as high a self-induction as possible. While in the early days of power transmission self-induction in transmission lines was carefully avoided in transmissions where a large part of power is taken up by synchronizing apparatus, such as rotary converters and synchronous motors, a considerable amount of self-induction in the lines is now considered desirable. In fact, if the line has too small a self-induction, as when cables are used, it is intentionally inserted in the form of reactive coils. Ths is the case in the St. Anthony Falls power transmission, which is now being installed for operating the railroads of St. Paul and Minneapolis by a number of 600 kw. rotary converters.

The receiving apparatus in Schenectady consists of two synchronous motors of 500 kilowatts and 100 kilowatts respectively for the testing department, and three rotary converters of 400 kilowatts for the operation of the factories. Air-blast transformers of the standard General Electric type are used for transforming the pressure.

At present the testing department is operated from an entirely separate power plant to secure complete independence in speed and voltage from the factory power plant. A large engine drives an M. P.-4-500-375-550 railway generator, supplying power at 550 volts to the motors in the testing department, and a smaller engine drives a number of exciters to give independent and complete control of the excitation of all machines in the testing department. An A. P. B.-12-500-400-10,000, 12-polar synchronous motor of 500-kw. rating and 400 revolutions, of revolving field type, and wound directly for 10,000 volts, will replace the engine now driving the railway generator supplying power at 550 volts to the motors in the testing department, while an A. P. B.-8-100-600-10,000, 8-polar synchronous motor of 100-kw. rating and 600 revolutions, also of revolving field type, and wound for 10,000 volts, will drive the exciter plant. By this means the testing department is made entirely independent of all changes but the frequency, that is, the speed of the generators in Mechanicville, which will be kept constant, or will at least vary only very slowly, due to the large size of the station.

Synchronous motors were chosen in preference to induction motors. It is considered very undesirable ever to use an induction motor where a synchronous motor can be used, for these reasons: Synchronous motors do not produce lagging currents as induction motors always do, so that the question of power factor does not enter into consideration, but the phase displacement in the synchronous motor and its power factor can be made anything desired by controlling its field excitation. Synchronous motors are necessarily more constant in speed and more efficient than induction motors. When of the

revolving-field type they are self-starting from rest with light load, and even with fairly heavy load, and also have an overload capacity, limited only by the heating of the motor. That is, any well designed synchronous motor will easily carry two or three, or even more, times its full load without dropping out of step for a time limited only by the heating of the motor, while induction motors, when built for such overloads, necessarily give at ordinary loads a very low power factor and poor efficiency. Mr. Steinmitz states that he has never been able to drop a synchronous motor out of step by overload, but that he had succeeded in dropping a 75-kw. synchronous motor out of step by a load of 140-kw. when reducing the impressed voltage to one-half. Considering the output as proportional to the square of the impressed voltage, this would represent an overload of 7½ times full load. The excitation of these synchronous motors is constant.

Three double commutator rotaries, type T. C.-10-400-480-2x250 are in the power house, each containing two commutators and two sets of collector rings, fed from independent secondary coils of the same set of air-blast transformers. In multiple these commutators give 250 volts for the operation of the factories, while in series they give 500 volts for testing. All the rotaries will be operated in parallel, and all motors in the factories, the factory railway, the lights in the factory, and office building will be operated from the same direct-current circuit; also the lights on the Edison three-wire system. To secure the neutral wire of the lighting system, the step-down transformers of the rotaries are connected in Y with their secondaries, and a lead brought from their common connection to a lighting neutral. Since the circuit of a rotary is neutral point also for its direct-current circuit, it can be used to feed the neutral conductor of a direct-current, three-wire system operated from the commutator brushes of the rotary.

In this transmission plant it has been considered desirable to secure extreme simplicity, and leave nothing whatever to hand regulation, but make the whole system self-regulating for constant voltage, in the direct-current distribution system. For this purpose all the rotaries are supplied with shunt fields and with very powerful series fields, which are all joined together so that the rotaries in operation form one unit. The rheostats in the shunt and series fields will be set so that with constant voltage in the generating station at no load the counter e. m. f. of the rotaries as given by their shunt fields is below the impressed e. m. f. and a lagging current produced thereby. With such a lagging current the self-induction of the lines is in opposition to the voltage, and reduces the latter so as to give the desired voltage of 250 at the commutator brushes of the rotaries. With increasing load the counter e. m. f. of the rotaries rises rapidly, due to the series field, till at full load and overload it exceeds the impressed e. m. f. and the current is made leading. With a leading current, however, the e. m. f. of self-induction of the lines is brought partly in phase with their voltage, and thus increases it, so that in spite of the increased line current, and thus increased energy loss in the line, with constant generator voltage, the same voltage is produced at the commutator brushes of the rotaries at full load and overload as at no load.

This control is perfectly automatic, and would be sufficient, if the synchronous motors did not take power also over the same line in amounts varying independently of the load on the rotaries. To take care of this small series transformers will be inserted in the lines leading to the synchronous motors and feed a small synchronous motor generator, which controls the shunt fields of the rotaries, so that, independent of the load on the lines and the distribution of the load between the synchronous motors and the rotary converters, the voltage will automatically be maintained constant at the commutator brushes of the rotaries by the combined action of their shunt and series fields, leaving nothing for hand regulation except the readjustment of the rheostats in case of a change of the number of rotaries in operation.

Pneumatics

AN ELECTRO-PNEUMATIC TRANSMISSION.

A unique transmission plant has recently been installed at Ely, White Pine County, Nevada, for the Chainman Mining Company, by the Westinghouse Construction Company, under the engineership of Mr. W. V. Lockwood, of San Francisco. Water for the operation of the plant is taken from a spring whence it flows through 1 1-2 miles of ditching and 1800 feet of 24-inch slip joint pipe to the power house, where it is applied to a 5-foot tangential wheel under a head of 500 feet. Direct coupled to the water wheel is a 120 kilowatt Westinghouse two-phase generator supplying current at from 0 to 2400 volts to four number 4 B. & S. bare copper wires leading to the mines, not quite three miles distant. At the mines the circuit is led through a switchboard possessing no distinctive features, to a 150 h. p. Westinghouse two-phase induction motor which drives a duplex air compressor, compressing air into three receivers, each measuring 12 feet in length by 5 feet in diameter.

It is from these receivers that air is taken for the operation of all the machinery about the mine. In detail, this consists of one 60 h. p. hoist, driven by two 10 by 12 engines; one 10-stamp mill, driven by a 10 by 30 Corliss engine; a cyanide plant, driven by an 8 by 24 Corliss engine; and two 6 by 12 simple engines which drive the rock breakers, the concentrators and the electric light plant. In addition, a single sinking pump lifts 20 inches of water up the shaft to an elevation of 230 feet. The compressed air is all reheated before being used and for this purpose there are three reheaters consuming one-half a cord of wood daily.

It should be understood that for all practical purposes the generator is rigidly connected to the air compressor, as there is no device installed whereby the motor may be switched off or on by any variation in the pressure of air in the receiver. Instead, however, three signal circuits are carried from the receivers to the power house and by means of these, the burning of a red incandescent lamp indicates that the pressure of air in the receiver is above normal; the burning of a green lamp shows that the pressure is too low, while the burning of a white lamp signifies that the normal pressure prevails. The station attendant varies the speed of the generator according to the signals received, thereby controlling the compressor as required.

Prof. Hutton states that two dangers beset engineering schools, the first of which is the danger of conferring the degree on mathematicians who are not and never can be engineers in the true sense of that term, and the second danger is the shutting out from the profession some who, by reason of their talents in some special field of engineering, would rise to distinction.

Metallurgy

PLATINUM IN GOLD PLACER DEPOSITS.

The constantly increasing demand for platinum in the arts and manufactures of the world and the present limited sources of supply, have in recent years greatly enhanced the price of the metal. Because of the peculiar and valuable qualities of platinum it is believed that the consumption of the metal would be greatly increased if the supply was sufficient to materially lower the cost.

This article is published, therefore, for the purpose of calling the attention of prospectors and miners to the increasing demand for the metal, even at present prices, and to the wide distribution of the ore, with the hope that by their aid new and rich deposits of the same may be located.

Contrary to popular impression, platinum and associated metals are widely distributed, although they have thus far been found in paying quantities in but few localities. This condition is perhaps largely due to the higher intrinsic value of gold and to the limited acquaintance of prospectors and miners with the means of identifying platinum ore and of its economic separation. Up to the present time the platinum of commerce has been obtained entirely from alluvial deposits, although it has been reported in limited quantities in its natural position. About eighty per cent of the present supply is derived from the alluvial deposits of the Ural Mountains, but there are few, if any, of the gold-bearing gravel beds of the world that have failed to yield platinum, and it is more than likely that large quantities of platinum ore have been thrown away with the black sand washings from gold placer deposits. The distribution of the ore may in fact be regarded as practically coexistent with gold placer deposits, as is evidenced by the following list of localities, excepting Russia, that have yielded the ore in varying quantities. In California in nearly if not in all of the gold-bearing gravel and sands; in Oregon, Georgia, North Carolina, Alaska on the Yukon River, Canada, British Columbia, Mexico, Columbia and Brazil, South America and Australia.

The genesis of native platinum is not well understood. In two cases it has been reported as found in quartz veins, but these reports have never been verified, and the theory of deposition from solution based upon them is rendered extremely doubtful, by the known insolubility of the metal. The undoubted occurrences of platinum in its natural position are in Russia, Brazil, New South Wales, Canada and Colombia.

Platinum ore is usually found in the form of rounded or flattened grains or "sand," occasionally in irregular lumps of the size of peas; large nuggets are very rare—the largest as yet found weighing twenty-one pounds.

The ore has a metallic lustre and is distinguished by its steel gray color, shining light gray streak when rubbed on a hard white surface, high specific gravity (16 to 19), infusibility in the hottest blast furnaces and insolubility in any single acid. It is not affected by borax or salt of phosphorus before the blowpipe, except in the finely divided state, when reactions for iron and copper may be obtained. It is soluble only in hot nitro-hydro-chloric acid.

Platinum ore is a complex body consisting of the metal in combination with varying proportions of the other members of the platinum group, such as iridium, rhodium, palladium, ruthenium and osmium, together with from four to twenty per cent of iron. In alluvial deposits the ore is generally associated with iridosmine (a native alloy of iridium and osmium possessing a degree of hardness superior to that of hard-tempered steel), magnetic iron sand, chromite, garnet, epidote and often with zircon, serpentine, ilmenite, peridot, quartz, diamond and chrysolite. Russia is the only country, excepting possibly New South Wales, that at the present time mines platinum ore for itself alone.

In the former country the platinum-bearing sand is found at depths of between six and forty feet, the "pay streak," averaging less than a foot in depth, resting directly on serpentine bed-rock. In New South Wales the "pay streak" is from sixty to one hundred and fifty feet wide and underlies a loam bed sixty to seventy feet deep, the ore occurring in the crevices of the bed-rock and in the gravel resting thereon.

The method generally adopted for extracting the ore is to pass the sand and gravel with water through puddling machines or revolving conical screens; the platinum and fine sand pass through into sluice boxes beneath, while the coarser materials are discharged at one side. The contents of the sluice boxes are washed in the usual manner, and when gold is present in paying quantities it is removed by amalgamation with mercury, the platinum remaining behind. Experience shows that it is seldom profitable to work mines yielding less than three grams of platinum ore to the ton of gravel. The average yield of the richest Russian mines is about six grams per ton. The refining of crude platinum is a difficult operation to perform and requires apparatus and experience not generally available, except at the hands of specialists.

The platinum nugget illustrated full size on this page is, undoubtedly, the largest ever found on this continent. It measures approximately three by two and three-quarter inches and weighs nearly two pounds. It was shipped to Baker & Co., of Newark, N. J., from the western coast of South America in February, 1897, but the facts appertaining to its discovery and early history are obscured by reason of its repeated transference from owner to purchaser. The illustration also shows in the lower right-hand corner crude platinum sand of the average form and dimension.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

OFFICIAL ORGAN OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

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EDITORIAL.

WORKING OUR WAY ABROAD.

The press has recently announced that the London office of an American electrical concern has closed an important electric railway contract with the companies operating the tramway systems of Dublin, Ireland, and Barcelona and Madrid, Spain. The Dublin contract comprises six 500 horse power engines; six 500 kilowatt multipolar railway generators, 3000 horse power of water tube boilers, and 150 complete street railway equipments, with trucks, all being of American manufacture. The Spanish contract was also of American build exclusively, and included 2000 kilowatts generator capacity, together with full station equipment.

Speaking in generalities, the perfection of the details of efficiency and adaptability seems to be the ambition of European engineers, and so great an extent has this aim prevailed that each installation appears to possess every possible refinement, worked out with the utmost nicety to fit the conditions which exist. All this is exemplary and it is worthy of emulation to the fullest extent, but American manufacturers are in a business world pervaded with an industrial atmosphere peculiar to itself, as a result of which its products, too, possess distinctive features. May not the efforts of European engineers be properly likened to those of the electrical manufacturer who attains the highest possible transformer efficiency under a given load, and are not the efforts of the American engineer comparable to the endeavors of the electrical manufacturer who attains the highest possible "all day" efficiency in the transformer he builds?

The machinery patterned after the ideas of the European and American schools of engineering is now in the marts of the world and whichever receives the greatest patronage will win the coveted prize of a name for superiority. This much seems evident, however, that American apparatus is not only holding its own at home, but it is actually working its way into European markets.

TWO SISTER SCIENCES.

It is futile to hope that engineering will reach the highest plane of excellence through the channel of a single one of its branches, and with a problem embodying diversified conditions it is oft-times unreasonable to maintain otherwise than that the products of different fields of engineering will afford the materials from which may be derived a perfect practice or the nearest approach thereto. Steam will always have its exclusive sphere of usefulness, and so will compressed air, electricity, and all other lines of engineering, but for the pneumatic engineer to close his eyes to the frequent superiority of electricity, or for the electrical engineer to condemn compressed air as fit to fulfill only limited services, are unworthy expressions. In mining, for instance, pneumatics and electrics each have, on occasions, peculiar fitnesses unapproached by any other agency, and in the harmonious working of the two, each to subserve the purpose for which it is especially adapted, will be found the nearest approach to ideal engineering.

The first instance in which compressed air and electricity have been systematically harnessed, is found in the transmission plant recently installed at Ely, Nevada, as described elsewhere in this issue. The transmission proper is effected through the agency of electricity, the energy from which drives a compressor that, in turn, operates all the machinery about the premises, including hoists, stamp mill, rock breakers, concentrators and the cyanide plant. The electrical features of the plant are therefore restricted to a 120 kilowatt generator, the transmission line, and a 150 horse power induction motor, all the remaining equipment being operated by compressed air.

Unless local conditions afford a conclusive reason for the operation by compressed air of those portions of the plant as constitute an even load, it is questionable if the sacrifice in efficiency due to the conversion from electricity to compressed air will not overbalance the additional cost of motors to operate the even load referred to, albeit the steam plant formerly existing may be rendered idle. Electric power in any form affords the ideal mode of running stamp mills, rock breakers, concentrators and all other even loads in mining machinery, but with hoists, as with rock drills, there is little question but that compressed air furnishes a means of operation at present superior to that to be derived from the application of current taken from transmission

circuits. In fact, an inherent characteristic of polyphase motors is that they operate to best advantage when under constant or slightly varying load. Conversely, they are inherently but ill-adapted to the relentless fluctuations imposed by mine hoists of heavy duty. Such work is well taken care of by direct current apparatus, but the additional cost of its installation and the absence of economy in throwing out steam hoists when they can be operated perfectly and at a high efficiency by air, compressed by polyphase motors, turns the balance to the favor of pneumatics. The near future may, however, reverse this situation.

Nevertheless, the Ely installation is evidence of a long step in an interesting direction and the success it will probably achieve will add to the rapidly growing conviction that pneumatics and electrical engineering are sister sciences, helpful alike to each other.

THE TRUTH, BUT NOT THE WHOLE TRUTH.

An article in the Cosmopolitan for December on, "A Greater National Newspaper," conveys the impression that there does not exist in America today a single daily newspaper that is above sectarianism, or party affiliation, or business association, sufficiently to be accepted as the embodiment of all that is desirable in both its news pages and editorial utterances. Without doubt class or trade papers are not to be included in the same category, for in their ranks are to be found noteworthy exceptions to the odium that attaches to the biased expressions of the publication that "has an axe to grind." Truly has it been said that you can fool some of the people all of the time, and all of the people some of the time, but not all of the people all of the time.

As with newspapers, so with advocates in every line of business; but one is quite unprepared for the concealing of an iota of truth by an able engineer and writer of no little just renown who, in comparing the revolving field with the inductor type generator, gives preference to the former because the inductor type "requires very high density in its magnetic structure, and thus gives a lesser margin in voltage and speed than the revolving field type, which latter allows the use of a fairly low saturation of the magnetic circuit, thus giving a nearly straight saturation curve. Such a saturation curve, while making the machine slightly inferior in regulation to the same machine with an over-saturated magnetic circuit, is preferable in power transmission. It allows a considerable increase of voltage when needed, for instance, to cover excessive drop in voltage in lines due to heavy loads, etc., and permits the voltage to be maintained, even if the speed is low, as in the case of water, etc."

It would be absurd to intimate that the writer referred to is not perfectly familiar with the fact that the Stanley generator, for instance, which is typical of inductor machines, does not require such density in its magnetic structure as to necessitate running at a serious closeness to the saturation point. Indeed, this inductor is not only capable of increasing the e. m. f. 20 per cent above normal by excitation, but in addition it is provided with an armature coil connecting switch, termed a regulator head, which may be constructed to produce an e. m. f. of any desired range either above or below normal, without any extraneous devices. The increase or decrease in voltage that may be obtained from the Stanley inductor is, therefore, far beyond that range attainable from single variations in degree of saturation. Of course magnetic regulation presents the advantage of being both instantaneous and automatic in action, and while embodying this mode, inductors for the reason given are capable of far exceeding the limit of regulation by magnetic means. The amount of this excess regulation which may be required is easily determined in each specific installation, after which the regulator head may be set as desired, precisely as though the degree of over-compounding necessary was manually effected. The admitted inferiority of regulation in a machine with a straight saturation curve, to one having an over-saturated magnetic circuit, renders further consideration of the proposition unnecessary, until the whole truth is told, when the honors regarding the regulation of revolving field and inductor type generators may be more understandingly considered.

Passing Comment

An Editorial Review of Current Events and Contemporary Publications.

PURE POLITICS, THEN PUBLIC OWNERSHIP.

From the evidences at hand (which, it must be admitted, may be of a doubtful nature, inasmuch as they are from the columns of the possibly subsidized press), it appears that Socialists will not find a crumb of comfort in the years of experience which the city of Philadelphia has had in owning and operating a gas plant. The end of this municipal control was reached last month, when a Court of Common Pleas decided that no injunction may stand restraining the city from leasing the gas works for a long period to a private corporation. The weight of the opposition to municipal control becomes tangible in the assertions made that such concerns as Cramps ship yard and the Baldwin Locomotive Works, through their managements, together with scores and scores of other most solid business institutions of the city, supported the lease.

In 1895, Mayor Stewart, in his annual message to the City council, gave an exhaustive and indeed, roseate report on the gas plant. It appeared from his report that the total expenditure of the gas bureau from 1891 to 1894 inclusive for material, labor, supplies, etc., were $10,858,910.58, and for extensions and permanent im-

provements,$1,050,248.81, making a total of $11,909,-159.39. During the four years previous there was returned into the City Treasury as receipts for the gas plant, $14,790,404.25, or nearly $3,000,000 in excess of the entire expenditure. The report commented on this as being a very good showing in face of the fact of a reduction from $1.50 to $1.00 per thousand feet, while the quality of gas remained the same. In addition, nearly two and one-half million feet of gas was furnished for street lighting, for which the gas department received no credit and which, had the city been compelled to purchase at even one-half the price paid by private consumers, would have cost, $1,649,651.00—which was also looked upon as a clear profit.

It is indeed a great drop from the very favorable showing of Mayor Stewart's report ,to the occurrences of the past month, wherein the principal tax-payers of the city have, from all accounts, risen in revolt to the further squandering of their money in the maintenance of a gas plant that has proven a sinking fund wherein millions are annually absorbed by unbusinesslike methods and the machinations of political cliques. No private corporation would adopt as a permanent policy the buying of a commodity from a second concern at a far higher figure than it could possibly sell it to the public, yet this is what the municipal plant of Philadelphia has been doing, and which, along with many other things, has wrought its ruin.

Still, after all, it does not appear that the failure of the city gas plant in Philadelphia is so much an arraignment of Socialistic theories as it is an evidence that the time is not yet ripe for municipal ownership in the larger cities, and as it is a bitterest condemnation of the incompetence and unworthiness of American politics.

ELECTRICITY AND THE PRESS.

The great conflagration which visited the English metropolis on November 26th and which destroyed property variously estimated from $5,000,000 to $40,000,000, has been attributed to the explosion of a small gas meter in Well street, and now the old controversy as to the relative incendiary proclivities of gas and electricity bids fair to be reopened by the English electrical press. The London Electrician observes: "Man's old enemy Gas, had another beginning in London last week." Then after reviewing the cause and consequences of the fire, it quotes a surveyor for fire insurance risks in London as stating that "Electricity is no longer the bogie it was, and I wish there had been more of it and less of gas in Well street."

It seems rather late in the game, however, to invite discusion of the long-since-settled question as to whether in gas or electricity is to be found the greater fire-bug, but nevertheless, so industrious is the daily press concerning electrical affairs that had a fire as disastrous as the London conflagration have been attributed to electricity as its origin, the public would not have had to await the slow channels of the trade or technical press for full information concerning it. The eyes and admirations of the family of man are lovingly centered on the infant science and its every developing trait of character is watched parentally with favor or fear according to its tendency. Though grown to stature and even in many respects ahead of its day, the quondam "infant" is still an infant indeed in the eyes of the human family, and if the child (?) knows nothing more, it has certainly learned already that fire cannot be played with without administering burns, and it hurts to be burned. Electricity has learned its lesson well and avoids every feature that may lead to disaster in this direction, but still the people of the world look on as parents are wont to do, overlooking the maturity of their offspring and fearful lest it does not know enough to "come in out of the wet."

May there not be found in this idea a reason why the daily press—that self-annointed custodian of the public weal—never ceases to prate on matters electric?

AN ELECTRO-HYDRAULIC ANALOGUE.

The "Engineering Magazine" (Nov., '97), in referring to the description of the electric transmission plant of the Power Development Company, of Bakersfield, Cal., appearing in the Journal of Electricity for August last, observes that an interesting feature of the plant is that practically all of the power is used in pumping water for irrigation purposes. After outlining the mode by which this is done, the "Engineering Magazine" points out that the Bakersfield plant offers an example of transformation of water not dissimilar to electrical transformation, in that a moderate volume at high pressure is transformed into a large volume at low pressure, and the intervention of the turbines, generators, and electrical transmission forms an intermediate detail of this unique installation.

AN OXIDATION RESISTING ARC CARBON.

A German electrical contemporary publishes an account of a Russian patent for the manufacture of carbons for arc lamps. These carbons are composed of the purest possible carbon and carbide of silicon pulverised very finely, mixed and united with a binding material, such as tar. A mixture of 90 per cent of carbon and 10 per cent of carbide of silicon is found to be a very good proportion, but it may be varied. They can also be made with a core of carbine of silicon, or with threads of the latter combined with some such conductive body as carbon. Since carbide of silicon is only formed at about the temperature of the voltaic arc it does not contain volatile ingredients and it has the highest power of resisting oxidation of all known bodies. It develops light of a greater intensity, and in consequence it appears to be well adapted for the purpose, but as carbide of silicon does not itself conduct electricity, it can only be used in the voltaic arc in conjunction with carbon.

Electro-Therapeutics

ACCUMULATORS IN DENTISTRY.

ELECTRICITY, in its wonderful progress, has not hesitated to encroach upon every avenue of industry, from the displacement of the mule, in the coal mine, to the radiating of a soft, mellow and perfect light in the stores of merchants or in the homes of the well-to-do. Steam, that emblem of civilization, which has long been looked upon as the ne plus ultra of human progress, no longer holds an undisputed field, and indeed, it is not usually necessary to consider its installation if water power is available within a reasonable distance from the point of consumption. From such heavy work as drawing a railway train, one can turn to the same subtle force toiling on with equal faithfulness, running a fan, silently and steadily, at the bedside of the sick, or coming to the rescue of the factory girl, who, day by day, bends over her sewing machine and blesses the little electric motor that lightens her task and increases her earnings. This magnificent science reaches into every avenue of business, and dentistry is not the last to awake to the new era and discover the comforts, conveniences and luxuries that electricity affords.

The dental profession has long realized in the good old treadle engine a staunch and faithful friend, yet it has not kept pace with the times. The first substitute suggested was doubtless the water motor, but this did not meet all requirements and its use is now uncommon. Then a simple but efficient electric motor—the Griscom motor—was put upon the market to meet the demand for a small power, but as the only available means for supplying current for its operation, was by the use of troublesome acid batteries, its field of usefulness was limited. Indeed, the experience of years has taught the lesson that acid or primary batteries will seldom prove satisfactory or economical where a continuous current of electricity is required for any considerable length of time. The installation of electric power circuits then followed and all small power consumers believed that with the advent of these circuits would come the day when the problem in question would be satisfactorily solved. The motors worked nicely; the speed was under almost perfect control and all was serene. About this time, however, electric mallets came into use, and it occurred to more than one that it would be a good idea to run the mallet from the power circuit. The experiment was tried, but, at the time of their introduction the current on the power circuits was generally at high potential and the early experimenters in some instances realized that no sooner had the mallet reached the teeth of the patient than a shock of varying severity was administered the patient. These shocks were caused by the leakage of the then dangerous current to the ground through the patient's body, and it is fortunate for the interests of the electric motor industry that no fatality occurred. Now, however, these high pressure currents are no longer utilized in the principal cities of the country, if at all, and nearly everywhere low tension direct current circuits are available from which even mallets may be operated without fear of injury.

Electrical accumulators, as storage batteries are sometimes called, have now been placed on a high plane of perfection and their importance is becoming more and more marked. As its name implies, the storage battery is a reservoir in which electricity or its chemical equivalent may be accumulated or stored. The process of this accumulation, though not as simple as the dozen analogies that might be named, is yet such as should be well understood by one with a slight knowledge of chemistry. The battery, or cell, in its simplest form consists of two grids of cast lead separated by strips of gutta percha or vulcanite forks. In practice, it is found convenient to multiply the number of plates of lead according to the storage capacity the battery is to have, and ordinarily an accumulator consists of a given number of plates, five, for instance, three of which—the negative plates—are joined to a common lead bar forming the negative pole of the battery, and the remaining two—the positive plates—are burned together to a second lead bar which forms the positive pole of the battery. By removing the insulating separators, the pile as it is called, may be resolved into its component parts, the positive and negative sets of plates. In one of the earlier and more easily explained form of storage batteries, these plates are each formed of a lead grid, and into the squares of the positive plates was compressed a paste consisting of minium or red lead (Pb_3O_4) and sulphuric acid (H_2SO_4); while the squares in the negative plates were filled with a paste of litharge (Ph O) and sulphuric acid. The pile was then connected together by means of insulating forks and after being submitted to a "forming" process of over a week's duration, the battery was ready for the market. After placing the pile in the cell containing dilute sulphuric acid and after forcing a current of electricity through it, the battery became charged, or in common words, the current was stored.

This process of accumulating electricity may be briefly described as follows: It is well understood that in all chemical batteries electricity is manifested as a phenomena attending the reduction of some metal, generally zinc, to one of its salts. When the storage battery is first set up and immersed in sulphuric acid of the proper specific gravity, no current can be drawn from it and it is not until after the battery has been charged that it is capable of delivering electricity. This charging process consists in passing a current through the battery and effecting thereby the reduction of minium to lead sulphate (Pb_3SO_4); the reduction of lead sulphate to spongy lead, and the formation of sulphuric acid.

The chemical action is as follows: During the passage of the current in charging, the sulphuric acid (H_2SO_4) of the solution unites with the minium or red lead (Pb_2O_3) of the positive plates and the oxygen set free from the same pole, forming lead per oxide (PbO_2), plumbic sulphate ($PbSO_4$) and water (H_2O), according to the equation,

$$PbSO_4 + 2H = H_2SO_4Pb.$$

The PbO_2 which is formed slowly accumulates in the bottom of the cell in the substance known as "per oxide mud." while the $PbSO_4$ combines with the hydrogen set free from the negative plate as follows:

$$Pb_3O_4 + H_2SO_4 + 2O = PbO_2 + 2PbSO_4 + 2H_2O.$$

thus forming spongy lead and adding H_2SO_4 to the liquid. It is plain that this addition of sulphuric acid to

the liquid during charging must result in constant increase of the amount of sulphuric acid in the liquid or electrolyte.

Though it may appear at a glance that serious injury might occur to the cell by reason of this increase of acid, such is not the case, for as the specific gravity of the liquid increases the charge in the battery increases and by the use of the hydrometer a certain indication of the amount of current in the battery is had. In discharging the battery the process is reversed, hence if the hydrometer shows the specific gravity of the electrolyte to be but 1.160, then the current in the electrical reservoir is near the bottom, so to speak.

If the hydrometer reads 1.200 there is no need of further charging, as running more current into the battery would be like pumping water into a tank already filled to the brim.

Having obtained an idea of the construction and principles of the storage battery and in order to explain satisfactorily its capacities and capabilites, it will be necessary to have some slight knowledge of electro-techniques. It must be learned then that what is commonly called a current of electricity is a composite substance or thing, we know not exactly what. It has two factors, the volt and the ampere, neither of which can exist without the other, and it follows that if a current exists, it must exist upon something. That something is the metallic conductor through which it travels and if a current of electricity flows through a conductor, it encounters a resistance, the amount of which regulates the flow of current. In electricity, the unit of pressure or potential, or that factor which enables the electric current to overcome resistance and to do work, is the volt. The resistance offered by any conductor as opposing the flow of electric current, is measurable and the unit of such resistance is the ohm. It is the volt that pushes the working property of the current through the resistance of the conductor, and the unit of the working property referred to is defined as the ampere. No current can exist without a conductor for it to travel upon. That factor of a current known as the ampere can not alone traverse a wire, for the same reason that water can not be made to go through a pipe unless some forcing pressure is applied to it. Conversely it is impossible to apply a volt alone to a conductor, as it is obviously impossible to apply pressure unless there is something to which it may be applied. The mission of the volt is to force the ampere through whatever ohms of resistance there may be in the conductor.

The layman should now be in a position to again take up the storage battery. The pressure that is derived from each cell is about two volts, quite irrespective of whether the largest or smallest cell is used. If four cells are connected one after the other in tandem or in series, the combined pressure or potential of the battery of four cells will be four times two volts or eight volts, which is an electrical pressure that may not necessarily be exceeded in electro-dentistry. The current from these four cells will fuse quite a large piece of wire, yet it is quite harmless as may be demonstrated by placing the battery terminals upon the tongue.

While the voltage of every cell is the same, regardless of its size, the amount of current each contains is directly proportional to the surface of its plates. Current enough can be stored in one of the smallest cells made to return two volts and two amperes for four and a half hours, or as it is technically called, the cell has a capacity of nine ampere hours. That is, it will give a current of one ampere for nine hours, or two amperes for four and a half hours, etc. The capacity of a battery best suited for dentists' uses is about 150 ampere hours; hence, if a dental mallet requires one ampere to operate, this battery will contain enough current on one charge to run the mallet 150 hours either continuously or intermittently.

In this connection may be mentioned a feature of the storage battery that alone makes it pre-eminently the superior of all acid or primary cells. In the use of the latter excellent results are obtained for several minutes after a new solution has been placed in the cells. The battery soon polarizes, however, or, in plainer words, the chemical tension or stress of its elements are brought to a state of partial equilibrium and as a result of this polarization the current rapidly grows weaker, until in a comparatively short time, it is of no use. In happy contrast to this, is the action of the storage battery; it does not polarize or run down and a dental engine when run from a storage battery will work as strongly the last hour as it did the first hour. In continuing the comparison between primary and storage batteries it may be stated that in the latter are no zincs to wash and amalgamate, there are no carbons to clean and it contains no acids that need to be changed and renewed. It is a perfect institution that gives only perfect results.

The question may now arise, how is the flow of current from the battery regulated? and in answer it must be brought to mind that in mechanics with a given power, the more friction there is to be overcome, the less will be the effective work that can be done. So it is in electricity, for the amount of current in amperes that passes is in inverse proportion to the resistance of the conductor through which it travels. If a wire having a resistance of one ohm be connected across the poles of a storage battery, about two amperes of current will flow through the wire. If the wire has a resistance of two ohms, one ampere of current will flow, etc. This is illustrated in the use of the speed regulator, by means of which more or less German silver resistance wire is thrown into circuit with the battery and electric motor. When resistance is added to the circuit by depressing the lever, less current becomes available for driving the motor, and the speed is reduced, and vice versa.

It is thus by the insertion of resistance into, or its withdrawal out of, the circuit, that varying effects are obtained, such as changing the speed of a motor, or altering the brilliancy of an incandescent light. After this manner may be operated laryngoscope, cautery points, motors, drills, and other electrical devices, and there are perhaps none in the profession who will not appreciate the application of electricity to heating air in air bulbs for drying cavities before filling. Heretofore it has been necessary to resort to the spirit lamp to heat the air in the barrel of the bulb, but in the electric air blast all that is necessary to obtain hot air, is to press the thumb switch and a blast of air, heated to the desired temperature, is available. This heat, too, may be regulated by the rheostat.

Perhaps the most universal application of electricity to dentistry is in the use of electric motors for driving dental engines, buffing or polishing outfits, etc. With four cells of storage battery of dental size, any speed, or any power sufficient for dental purposes can be obtained under the most perfect regulation. At the foot of the operator is a rheostat, or speed regulator and depressing it to a greater or less extent, the motor is started and driven at any required speed. In event the drill point

becomes entangled in rubber sheeting, or if it is deemed necessary to reverse the direction of rotation, this is quickly accomplished by means of a simple switch moved by the foot. A majority of dentists using electric power are obliged to stop the motor, take off the belt and give it a half twist whenever they desire to reverse the drill. That this is not necessary is apparent. The motor is so constructed that it draws current from the battery in almost exact proportion to the work being done, hence practically no energy is wasted in maintaining a maximum power to meet a possible demand. The motor automatically and without the aid of any external mechanism instantly responds to whatever work is imposed upon it within its range and when its load or work is lessened, the consumption of current from the battery is decreased accordingly. The speed of the motor is practically constant and it does not slow down appreciably when performing ordinary work. When desired, however, the speed may be varied by means of the pedal regulator as described. The power given is more than ample to meet all of the requirements of a dental engine, and in proof of this statement, it is easily shown that a dental motor is capable of driving a surgeon's circular saw through a piece of bone an eighth of an inch thick. Perhaps the hardest work that can be imposed upon a motor in a dental laboratory is the running of a polishing lathe, yet this too is handled with ease.

In cases where abundant current for charging purposes is available it is a reasonable proposition to heat water for rinsing the mouth by electricity. To do this it is only necessary to take the proper piece of resistance apparatus from its hook and immerse it in glass of water. The act of raising it from the hook can be made to close the circuit and permits the current to run through the resistance wire about it which becomes hot and heats the water. It takes from one to three minutes to heat a glass of water to the proper temperature; hence, in practice, it is best for the operator to place the heating apparatus in the water soon after the patient takes the chair. In installations in which the storage batteries are kept charged by gravity batteries, the heating of water by electricity is not recommended because of the great amount of current consumed in the process.

There are several ways in which dental storage batteries may be charged. When the ordinary gravity, or blue stone battery is used, a small stream of electricity is constantly running into the storage battery, tending to keep it always charged. The gravity battery requires the least attention of any primary cell and the expense of maintaining it is but slight. Accumulators may be charged from any continuous current, electric light or power circuit, and many prefer to send their cells to a central station for recharging. None of these methods are without some trouble or expense and where arc light wires are used, the danger of personal injury from shocks is serious, owing to the high tension of the current that the wires carry. The charging of dental batteries from city direct current mains is easily done, but the means which must be adopted for cutting down the voltage makes the cost of charging high, and to run a charging dynamo from an electric motor supplied with current from city mains, involves considerable investment in apparatus. In order to avoid the trouble and inconveniences of acid batteries for charging, or the expense of obtaining current from a central station, or the danger attending the use of arc or motor circuits, some operate a miniature charging station which can be placed in every office where there is a fairly good water pressure available. It consists of a small water wheel and a still smaller dynamo that requires but about one-twelfth of a horse power to drive it. When the hydrometer indicates that the current is about drawn from the battery, it is only necessary to turn on the water, start the dynamo and the little machine will charge the battery as thoroughly as the current obtained from an electric lighting station. For the ordinary work of one dental chair it will hardly be necessary to run the dynamo oftener than one day in each week or fortnight, if the water pressure is good. If it is neither possible nor convenient to use the water wheel there may be a gas engine or other power in the building, from which the trifling amount of power required to run the dynamo may be obtained. In the country a small wind mill will furnish ample power to run the dynamo and the fact that the power may be unsteady or intermittent will make no difference in the operation of apparatus from the battery.

Transportation

FLOODING AN ELECTRIC CONDUIT ROAD.

The behavior during flood times of an electric street railway, operated on the General Electric open conduit system such as the Metropolitan Traction Co., of New York, is so extensively laying down, is of interest, as ignorance of it has formed one of the principal motives for decrying it. While no flooding of the conduit has ever occurred on the Lenox Ave. line, it has been averred that, if it were flooded, traffic would necessarily stop, owing to short circuit, until the water had been run off. That this is not the case is shown by an interesting experience on the line of the Metropolitan Traction Co. in Washington, D. C.

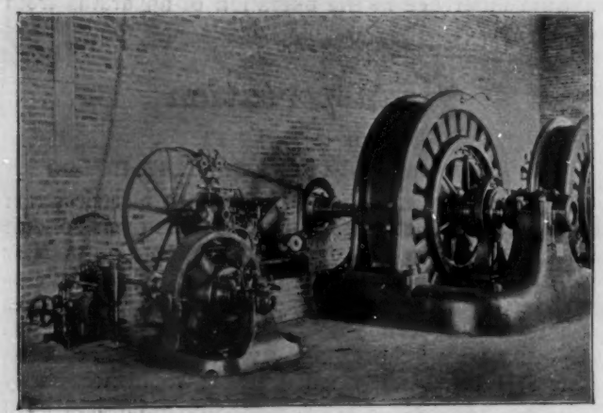
October 9th, 1897, as the result of a heavy rain storm, a stretch of track, some 150 feet long on the F street line, became completely flooded, the water filling and overflowing the conduit as it was unable to run off by the usual sewer connection, which was cut off. According to the statement of Mr. Weaver, President of the road, although the conduit was completely filled with water for nearly two hours, the station was not short circuited, nor were the water rheostats called into requisition. The normal load of the feeder for the section is 300 amperes, the loss during the time the conduit was flooded was 600 amperes, and the cars were also operated on the sections on both sides of that which was under water. The water was practically pure and this partially accounts for the small additional load.

The Washington electrical conduit system, although its conduit has been several times flooded, has never yet been tied up, except once when the water almost covered the floors of the cars and flooded the motors. At other times the line has been operated by means of a reducing rheostat. The present instance is the only one in which the flooded section has been operated directly from the generators without reducing medium. It was estimated that the pressure of the current on the cars in the centre of the flooded portion was about 250 volts.

THREE PHASE TRACTION.

The first trial trips on the electric railway up the Gorner Grat, near Zermatt, Switzerland, were carried out last month in the presence of the inspectors of the Swiss Railway Department. The section already completed

has a length of 1,600 metres and a gradient of 12 per cent. The tests gave complete satisfaction, both the ascent and descent of this gradient being effected without the slightest difficulty, the motors holding the locomotive perfectly to its proper speed. Starting on the maximum gradient with a fully-loaded train was also effected with great facility. The Gorner Grat road is a rack railway, the total length being about six miles and the maximum gradient 20 per cent. The power is derived from the Findelbach, which drives four turbines of 250 h. p. each, coupled directly to three-phase alternators of 5,000 volts and 40 alternations per minute. Transformers are placed in the power house itself for feeding the line as it passes the building, and two other transformer stations are provided. The tension of the trolley line is 550 volts. Each locomotive is equipped



with two three-phase motors of 90 h. p. each, driving the main pinions by spur gear.

Owing to the property of three-phase motors, by which they will act as generators and take up the full power which they are designed to give out as motors when driven at 2 or 3 per cent. above the speed of synchronism, the locomotives will, in descending, give power back to the line. In case only descending trains should be on the line, the surplus power will be taken up in a water resistance in the power house. The contractors for the whole of the electrical equipment are Messrs. Brown, Boveri and Co., who, in the well-known Lugano tramway, were the first to apply the three-phase system directly to traction. They have also supplied the electrical parts for the Jungfrau railway, where their system is to be adopted, and are now engaged on the equipment of the line from Stansstaad to Engelberg, which is to be running next spring. —London Electrical Engineer.

The Baltimore and Ohio South Western Railway has been experimenting with electric motors on turntables. Turning locomotives at divisional points and terminals is a service of much annoyance and no little expense to railroad companies, as it generally takes four men to turn a locomotive and while they are doing so their regular work is abandoned.

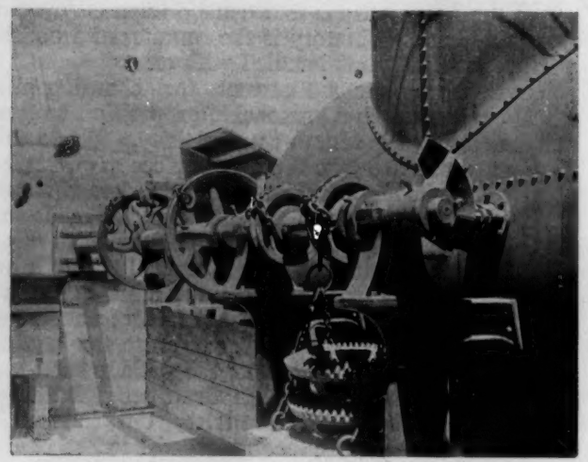
Experiments were made with an electric motor on the 60-foot turntable at Chillicothe with such success that the Park street turntable in Cincinnati was similarly equipped. The result has been rather astonishing in the matter of expense. The current was purchased from the power plant and it cost on an average of less than one-half a cent for each time the table was turned. When this same table was operated by hand it cost 12 cents for each engine. The yearly saving is about $709.

Hydraulics

INERTIA IN GOVERNOR MECHANISMS.

To The Editor: While reading the leading article on "Water Wheel Regulation" in your September number, I was impressed with the emphasis laid on one of the points made, namely, that sensitiveness in the government of water wheels is largely due to a minimum inertia of the moving parts of the governor. The conclusion seemed to naturally follow that if light, quickly-moved parts are material to success in one portion of the mechanism, they should be as light and as easy moving and as nicely balanced in all other parts of the governor as is consistent with mechanical strength, to secure close regulation.

This condition is not always believed in, or at least it is not always carried out, nor is its existence always necessary, and this statement will, I think, be admitted as correct after an examination of some of the devices that are used for regulating water wheels in the West. The accompanying photographs of a governor shaft in an electric power plant were taken a year or so ago and illustra-



te the point I wish to make, viz, that it is surprising that an approach to satisfactory regulation is possible with crude devices existing anywhere in the governor mechanism.

At all events, the water wheels of the plant referred to are considered to be well regulated ones, and as to the moving parts of its governor being of light inertia, the photograph tells its own story. C. S. J.

Denver, Colo., October 7, 1897.

Personal

Mr. Clifton Morton, Jr., local manager of the New York office of the National Tube Works Company, was recently on his annual trip through California.

Mr. T. A. W. Shock, formerly of the Sacramento Electric, Gas and Railway Company, has accepted the general superintendency of the Portland General Electric Company, to which city he has gone.

Mr Stephen D. Field, whose many important inventions in the electrical engineering field have added further to the world-wide fame of his illustrious family, and whose earlier electrical experiences were in California and the West, was a recent and most welcome visitor to San Francisco about a fortnight since. His trip West was for pleasure and recreation.

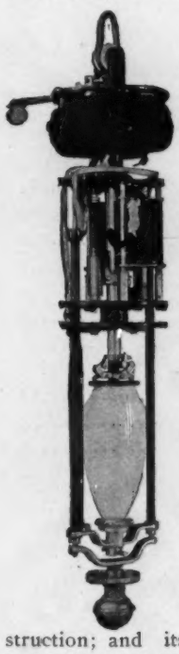
Mr. W. A. Burkholder, who is one of the most experienced

electrical transmission engineers in the country, is now in Alaska, but will probably locate in San Francisco. Mr. Burkholder has resigned the position of Gen. Superintendent of the Portland General Electric Company, which he has held for many years, but still remains in the directory of that vast concern, as well as in the directory of the Union Power and Willamette Locks and Transportation Companies.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

ENCLOSED ALTERNATING CURRENT ARC LAMP.



Perhaps the most objectionable feature of such alternating current enclosed arc lamps as have heretofore been placed on the market has been their too low economy and noisy, uncertain action. In the new alternating current arc lamp, manufactured by the General Electric Company, these characteristics are overcome. It operates on constant potential alternating circuits with higher economy and greatly diminished noise. The principles of the enclosed arc lamp and the economical advantages of its use over open arc lamps are familiar to our readers, but as between open and enclosed alternating arc lamps, it is not so generally known that a greater difference in economy in favor of the enclosed lamp is shown than in the same comparison between open and enclosed direct current arc lamps. In the G. B. alternating current enclosed arc lamp, one pair of carbons will last between 60 and 70 hours and induce a saving of about 80 per cent in the cost of lamp carbons; a larger arc is maintained; the light is emitted without obstruction; and its protection from currents of air and any sudden action of the mechanism allows the light to become and remain steady.

The mechanism is simple, the number of moving parts being reduced to a minimum, and its action is quick and positive. A special adjusting spring keeps the current constant whatever the position of the core. The mechanism is supported on a frame with a double base which gives a dead air space and provides protection for the mechanism from the heat of the arc.

This lamp operates on circuits of 100 to 120 volts and 60 or 125 volts frequency. About 70 volts are required at the terminals of the arc, and the normal current being 5.5 to 6 amperes. An inductive resistance contained within the ornamental top of the lamp, and connected in series with the arc, gives the necessary reduction in the voltage, and, preventing sudden changes in current, checks any unsteadiness of the light. The half-inch carbons used are 9½ in. long in the upper holder and six in., in the lower one cored, the other solid, and they must, of course, be of high grade. They are proportioned to allow the piece left in the upper holder after one run, to be used in the lower holder for the next. The inner globe is supported by a self-locking device. To lower the globe, the lower ball is unscrewed, the globe is raised slightly and released by turning the release screws on the side of the cylinder. To replace it, the globe is simply raised until it locks, when it is tightened by screwing up the lower ball.

The General Electric alternating current enclosed arc lamp is 28¼ in. in length and 31⅛ pounds in weight. It is artistic in its proportions and is judiciously ornamented. For interior illumnaton, i, e., for halls, large stores, restaurants, theatres, public buildings, the casing of the lamp is finished in ground brass or black enamel; for outside use a weatherproof casing is furnished.

ENLARGING THE BUFFALO-NIAGARA PLANT.

While the attention of the electrical transmission fraternity of the West is being absorbed in the development of their own enterprises, it is interesting to note the progress that is being made in the extension of the more prominent transmission plants of the East. Most noteworthy of these is, of course, the Niagara-Buffalo transmission, which is now undergoing a considerable increase, the demand for power from Buffalo having within the past few months grown beyond the capacity of the line first put up. The three wires strung on the poles, will have shortly three companions, and the white insulators on each pole, will be increased to six.

A new order for cable as well as for transformers has been placed with the General Electric Company. The cable is of special manufacture, is insulated to stand the ultimate pressure of the line, which will be 22,000 volts, and is tested under a considerably higher presssure before leaving the works. Twenty-four thousand feet of this cable will be used at first for that part of the transmission line within the city of Buffalo. The order for increasing transformers covers seven of similar size and design to the three now installed in the transformer house of the Niagara Falls Power Company. These ten transformers are the largest ever built. Each has a capacity of 1,250 h. p., making a total step-up transformer capacity of 10,000 h. p. They are of the air-blast type, and will stand in rows of four upon the air-tight chamber, whence the air is forced through the ventilating spaces in the transformers. It will be remembered that the two-phase current at 2,200 volts passes from the 5,000 h. p. generators in the power house to the transformers. In these it is not only increased in pressure but changed in phase, the current issuing from the transformers as three-phase current at 11,000 volts. This pressure will be adopted until it becomes necessary to increase it, when it will be doubled and be delivered to the transmission lines at 22,000 volts. On its arrival in Buffalo it will be delivered to the step-down transformers of the Cataract Power and Conduit Company, which controls its distribution there. The electricity will be transformed down to different pressures for distribution over a city network to different points for a variety of purposes, being used directly in induction motors, a number of which will probably be installed in grain elevators, etc.

Several step-down transformers will also be placed in the station of the Buffalo General Electric Company, and from these three-phase current, converted into direct current in rotary converters will be utilized for lighting purposes and for small power units.

The Buffalo Railway Co. is also increasing its step-down transformer and rotary converter capacity in its Niagara Street Power House. In addition to the two 500 h. p. converters already in operation, the General Electric Company has built two others of similar capacity and construction. These will bring the total converter capacity in the station up to 2,000 h.

p. To supply these necessitates the installation of three additional step-down transformers in the transformer house between the station and the canal. These will be of about the same capacity as the three already there—each of 275 kw., reducing three-phase current from about 10,500 volts to 375 volts for delivery to the alternating current side of the rotary converters in order that they may issue direct current at 550 volts, at which pressure it is delivered to the bus bars of the station switchboard.

While the foregoing equipments are exclusively those of the General Electric Company, the Westinghouse Electric and Manufacturing Company has closed important contracts in and about Niagara Falls as follows: The most noteworthy contract of the Westinghouse Company is that with the Cataract Construction Company for an enormous addition to the great station at Niagara. It consists of five 5,000 h. p. generators of the same pattern as the three installed at present. In addition to these five machines which are now under way,—in fact their shipment has already commenced,—the factory is also building exciters, representing a capacity of 675 h. p. The switchboard, with necessary appliances, controlling the five 5,000 h. p. generators, is also being made now and all of these machines will be applied to the Niagara Power House as soon as required.

The Niagara Falls Hydraulic Power and Manufacturing Co. some time ago, contracted with the Westinghouse Co. for six 750 h. p. direct current generators, 300 volts, 250 r. p. m. These generators will be direct connected to Leffel turbines and they will be used for generating current that will be supplied to the Aluminum Factory of the Pittsburg Reduction Co. at Niagara.

The company has also constructed two 300 h. p. two-phase induction motors, contracted for by the Buffalo-Niagara Falls Electric Light and Power Company, to be used for driving alternating current generators, direct current generators, arc machines, etc.

The Niagara Electro-Chemical Co. has contracted for a large increase in its transformer station, located above the power house of the Niagara Falls Power Company, and consisting of three 235 h. p. two-phase rotary transformers and one 175 kw. rotary transformer supplying current for the reduction of metallic sodium from caustic soda. In addition to these transformers, the Westinghouse Company is also making for the same company 800 h. p. in air-cooled oil converters, consisting of six 133 h. p. converters, 3,000 alternations, which will supply current for the rotaries.

The Acetylene Light and Power Co. has contracted for two 1000 h. p. oil converters, water-cooled, of 3,000 alternations, primary 2,200 volts, secondary 100 volts. These converters will supply current for arc furnaces for the manufacture of calcium carbide.

The Mathieson Alkali Company contracted with the Westinghouse Company some time ago for a number of rotary transformers, induction motors and oil converters, which were recently installed and consist of 11, 165 h. p. rotary transformers, several small induction motors, twenty-two 82½ h. p. oil converters, four 33½ h. p. oil converters, and two 13½ h. p. oil converters.

These facts are the best evidence of the growing activity manifesting itself in the use of electrical apparatus at Niagara Falls, all of which has been occasioned by the erection of the large power station of the Cataract Construction Co., the generators for which were installed by the Westinghouse Electric and Manufacturing Company.

ELECTRICITY IN MINE HAULAGE.

"The Operation of Electric Mining Plants" forms the subject of an attractive pamphlet recently issued from the press of the General Electric Company. It is devoted more especially to the installation, use and economy of operation of electric mining locomotives and lists, 75 electric locomotives aggregating 2,860 h. p. In addition to describing some noteworthy installations, the pamphlet contains valuable and apparently impartial data that is of exceptional interest to mining managers who are striving to attain the highest possible efficiency in mine haulage.

The publication of a booklet on the same lines with that just considered, but having for its theme the operation of mining hoists driven from polyphase motors, is next in order, and its advent is earnestly awaited.

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